Middle Truckee River Sediment TMDL Study: sampling methods

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Introduction

This study addresses the effect of sediment deposition on biological health within the middle reaches of the Truckee River (Lake Tahoe to CA-NV border). The study design employs sampling above and below tributary junctions of sediment input, determined from AnnAGNPS model projections of sediment load, and from empirical measures of turbidity and suspended sediments where possible. Sites located above the tributary junction may serve as controls for that tributary, integrating upstream inputs of sediment or other environmental conditions to that point. Downstream sites will be located along a gradient of increasing distance from the confluence. It is anticipated that there will be a change in the particle size distribution along this gradient depending on the nature and quantity of sediment input and the transport capacity of the river. Sampling will be conducted along transects on the same-side of the river as each tributary inflow. Tributaries will be selected such that there is both a range of potential sediment dosing due to varied landscape disturbance in tributary watersheds and representation of minimal watershed land surface disturbance to assess biological condition under natural conditions of sediment delivery to the river. This approach is designed to evaluate dose-response between tributary inputs of sediment and within the downstream gradient of varied particle deposition from each tributary. Localized sampling of invertebrates associated with different amounts of sediment deposition will permit dose-response analysis even if the tributary-loading of sediments occurs at a scale that is too large for the small-scale invertebrate sampling to represent.

Methods

Targeted Riffle Sampling

At each site a single targeted riffles sample, consisting of eight composited kick samples, was collected from riffles 25 to 125 m downstream of the confluence with each tributary. Kick samples were collected with a 500 µm mesh D-frame net by disturbing a one square-foot area upstream of the net for a constant effort (about 30 seconds) by hand. At sites with a sufficient number of riffle series available, two kick samples each were collected from each of the four longest riffle series, taken at mixed positions within each riffle series. If fewer riffle series were available, the samples were assigned by proportion to the size of each riffle. The kick samples were composited into a bucket, and processed to remove as much leaf and wood debris and sediment as possible. The remaining sample was strained through a 100 µm aquarium net and preserved in ethanol and rose bengal, a stain to aid in laboratory processing, for transport to the laboratory.

Core Sampling

Six core samples of sediment and associated invertebrates were taken at each site, one 50 m upstream of the confluence, one each 50, 100, and 250 m downstream of the confluence, and one each from downstream locations judged to have low and high levels of sediment deposition. Samples were located in areas dominated by gravel and pebble

substrate, with sufficient flow to prevent surface deposition of organic matter (i.e. pools were avoided), on the same side of the river that the tributary entered, and at depths ranging from 6 to 29 cm. Samples were located along the margins, rather than deeper, fast moving water toward the middle of the channel, both for accessibility and to sample from desired depth and substrate.

The core samples were taken using a handmade stovepipe sampler (Photo 1). A 16 cm inner diameter (200 cm^2 area), 30 cm length piece of ABS pipe was fit with a polyurethane foam collar that extended 2 cm beyond an inner-beveled edge at one end. The collar formed a seal around the sampler as it was pushed into substrate to be sampled. Once seated, the substrate inside the sampler was disturbed by hand to entrain sediment and biota and to remove any large pebble- and cobble-size substrate particles present. Three liters of water and sediment inside the sampler were then pumped into a bucket using a 4.5 cm diameter hand bilge pump (Photo 2). Following pumping, the sediment was disturbed once more by hand to entrain sediment and invertebrates, and five sweeps of the sediment surface were made with a 10 cm wide, 100 µm aquarium net, followed by one sweep of the water column.

Following collection, each sample was processed on shore as outlined in Figure 1 to quantify fine (i.e. <1 mm) fine granular and non-granular material, and to separate invertebrates for preservation and identification. Each sample was first passed through a 1 mm mesh, stainless steel sieve into a bucket and washed using a squirt bottle filled with river water. The coarse fraction remaining in the sieve was set aside for processing (i.e. removal of leaf and wood debris and sediment). The fine fraction was allowed to settle for three minutes, and then the supernatant was slowly poured through a 100 µm aquarium net so that less than one liter of settled particles and water remained in the bucket. Invertebrates and sediment in the net were saved as part of the invertebrate sample. The remaining sediment and water were poured into a one-liter capacity Imhoff cone, filled to capacity with supernatant, and allowed to settle for ten minutes. Imhoff cones were held in a metal frame mounted to a wood base with a bubble-type level (Photo 3). After settling, the volume of granular and non-granular sediment in the cone was recorded; this interface was generally obvious (inset, Photo 3; separating sand from clay-silt fraction above). The material in the cone was then processed. Following processing, invertebrates from all of the sample fractions were then collected and the sample was preserved in ethanol and rose bengal for transport to the laboratory.

Invertebrate Identification

Following transport to the laboratory, invertebrate field samples will be subsampled using a rotating drum splitter, sorted from subsamples under a magnifying visor and microscope, and identified to the lowest practical taxonomic level possible (usually genus; species when possible based on the availability of taxonomic keys) except for oligochaetes and ostracods, which were identified to order only. For the targeted riffle samples, a fixed count of 500 organisms are identified, with remaining organisms in a subsample counted but not identified to determine density. For the core invertebrate samples, all organisms will be removed from each sample for identification. Data analysis yields information on taxonomic composition by density and relative abundance.

Metrics of community structure will be calculated to express biological health in terms of diversity, composite community tolerance, number of sensitive taxa (mayfly-stonefly-caddisfly), dominance, and other measures of composition. All stages of sample processing and identification are checked using quality control procedures to assure uniformity, standardization, and validation (QAPP; Herbst 2001).

Sediment Dry-Weight Density

For reporting purposes, the dry-weight density of the granular and non-granular sediment fractions measured in the Imhoff cones was calibrated. These fractions appeared to form based on faster settling velocities of the larger, primarily sand particles versus smaller, largely clay-silt particles. Two additional samples were collected at the Juniper Creek site following completion of core sampling using the same procedure. Two samples each of the granular and non-granular fractions were collected and sealed in vials for transport back to the lab. At the laboratory, the volume of sediment in each sample was measured, each sample was dried in an oven at 60^{o}C, weighed, ashed in a furnace at 500 ^{o}C, and weighed again to determine both ash free dry mass and the mass of inorganic matter in each sample. The mean of the four replicates of both granular and non-granular fractions were used to calibrate the dry-weight densities of each fraction.

Results

Sediment Dry-Weight Density

The mean sediment dry-weight densities of organic and inorganic matter in the granular and non-granular Imhoff cone fractions are shown in Table 1. Each of the replicates was in good relative agreement, as indicated by the relatively low standard deviations, except for one of the four replicates for the inorganic fraction. This value was an order of magnitude different from the others, and therefore was excluded from the calculation of the mean and standard deviation. These mean values were used to convert volumes of sediment measured in the Imhoff cones into sand per unit area or silt-clay per unit area (and as organic or inorganic dry weight of each sediment fraction, or the total).

Table 1: Summary of mean ± standard deviation dry-weight density of organic and inorganic matter for granular and non-granular sediment fractions measured for core samples using Imhoff cones.

	Dry-Weight Density (g ml^{-1})	
Imhoff Cone Fraction	**Organic Matter**	**Inorganic Matter**
Non-granular (silt-clay) (n = 4)	0.026 ± 0.001	0.20 ± 0.03
Granular (sand) (n = 3)	0.040 ± 0.002	1.10 ± 0.09

[silt-clay fraction contains 11.5% organic content, sand fraction only 3.5% organic]

For total volume of 200 ml, and granular of 80 ml (photo 3), these core samples (200 cm^2 area) would be equivalent to sediment per m^2 as:
0.226 g/ml x (200-80) = 27.12 g /200 cm^2 = 1356 g/m^2 silt-clay fraction
1.140 g/ml x 80 = 91.2 g /200 cm^2 = 4560 g/ m^2 sand fraction (< 1mm)
TOTAL = 5.96 kg/m^2 combined sediment deposition

Figure 1: Flow diagram of core sampler sampling and processing procedure.

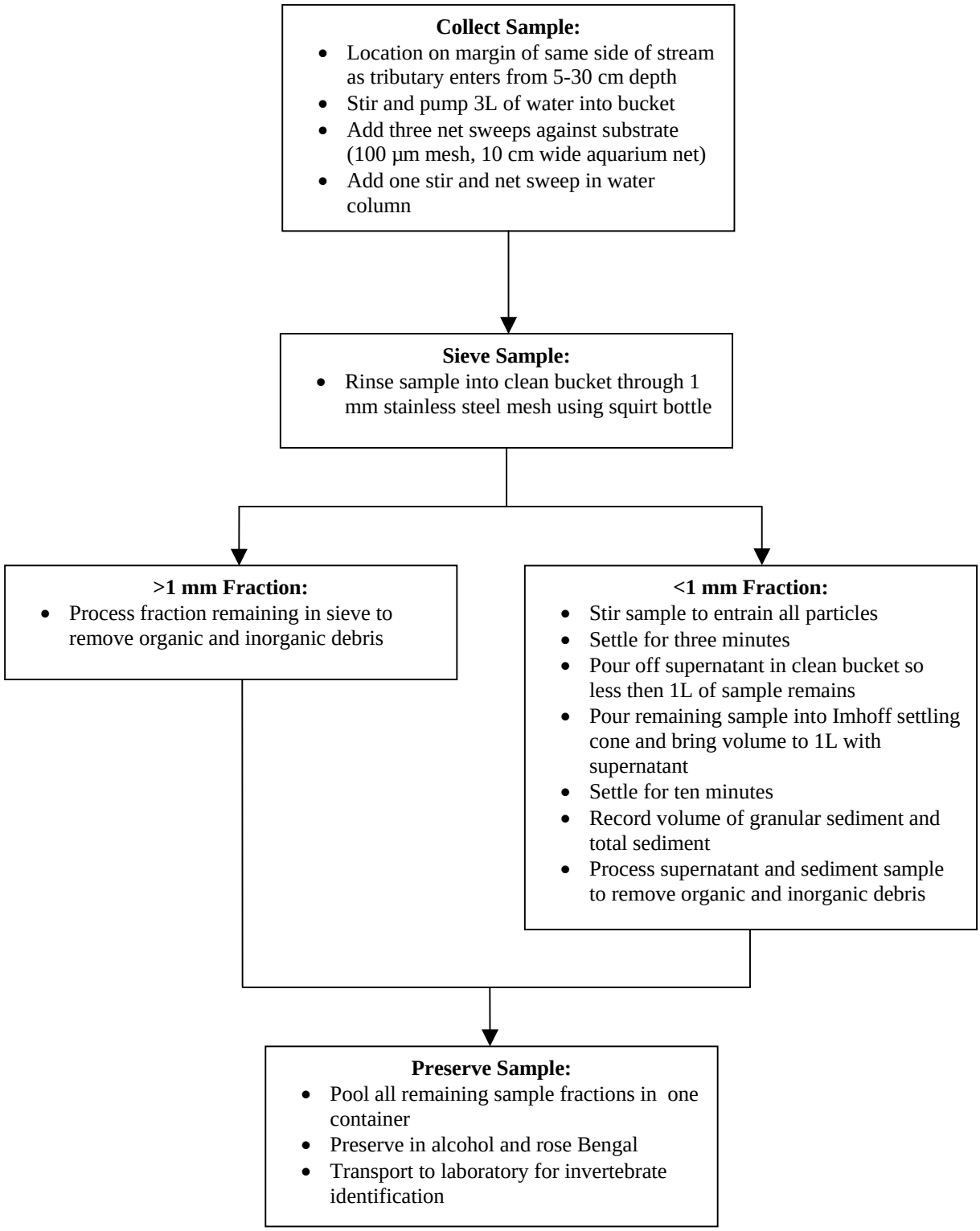

Photo 1: Core sampling and processing equipment, including stovepipe sampler, bilge pump, sieve, buckets, wash bottle, and Imhoff cones and mounting stand.

Photo 2: Pumping water and sediment from sore sampler with a hand bilge pump.

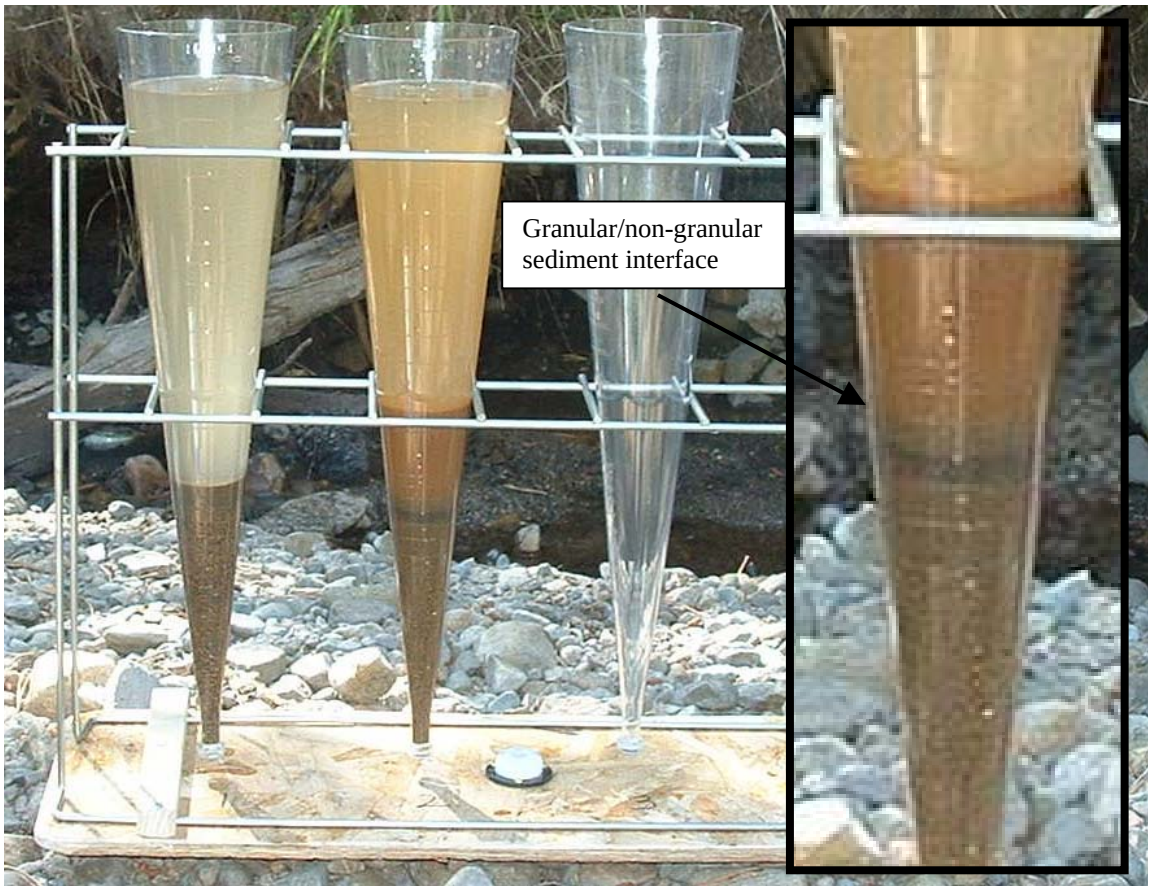

Photo 3: Imhoff cones with two samples settling. Inset photo is a close up of the right-hand sample showing the change in color from sediments that appeared granular vs. non-granular (i.e. darker- vs. lighter-hued, corresponding to coarse and fine sand in the lower fraction, and the easily re-suspended clay-silt fraction above).

Tributaries Selected for Sampling Above/Below:

Bear Creek
Squaw Creek
Trout Creek
Martis Creek
Juniper Creek
Gray Creek
Bronco Creek